A Comprehensive Fatigue Management Program and an Evaluation of a Photic Countermeasure for Mission Controllers

Completed Technology Project (2010 - 2015)

Project Introduction

The success of a human spaceflight critically depends on the interaction between the crewmembers and the mission controllers. The ability of both the crew and the controllers to be alert and to maintain high levels of cognitive function while operating and/or monitoring complex, technical equipment is essential. Optimal human health, performance, and safety during spaceflight operations requires sufficient sleep and synchrony between the circadian pacemaker—which regulates the timing of sleep, endocrine function, alertness, and performance—and the timing of the imposed sleep-wake schedule.

Flight mission controllers often work extended duration shifts, rotating shifts, including nights shifts. Such schedules instigate significant acute and chronic sleep deprivation and consequently fatigue. Although the effects are often unrecognized, both the acute and chronic lack of sleep substantially degrades a federal air marshal's ability to react and think quickly, to make good decisions, and to recognize when fatigue is impairing his or her own performance and safety. Further, both acute and chronic sleep deprivation adversely affects personal health, increasing the risk of gastrointestinal and heart disease, impairing glucose metabolism and immune function, and substantially increasing the risk of injury due to motor vehicle crashes. In addition, it is likely that a significant proportion of mission controllers suffer from undiagnosed sleep disorders which will further impair their sleep and exacerbate fatigue. The deleterious effects of fatigue are readily observed in a wide range of safety-sensitive professions, including law enforcement officers, and include increased risk of self-injury, higher rates of fatigue-related motor vehicle accidents, and greater incidence of serious errors.

We propose to implement a Comprehensive Police Fatigue Management Program for the flight mission controllers program. The goals of this program are to reduce the adverse consequences of fatigue on the mission controllers' alertness, performance, health, and safety. The overall goals of our team include developing an online education training program and an efficient sleep disorders screening, evaluating the acceptability, feasibility, and efficacy of a shorter wavelength photic countermeasure during operational night shifts and suggesting work-hour policies and guidelines, which can be implemented to improve the alertness, performance, health, and safety of mission controllers.

Anticipated Benefits

This outcome of this research could benefit those who work the night shift, rotating shifts, or other schedules outside the typical 7 AM-6 PM work hours.

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Table of Contents

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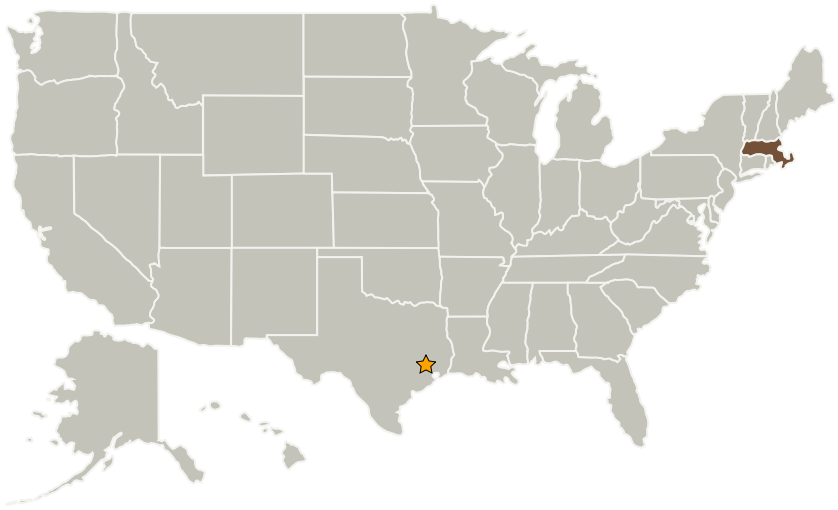
Completed Technology Project (2010 - 2015)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Brigham And Women's Hospital, Inc.	Supporting Organization	Industry	Boston, Massachusetts

Primary U.S. Work Locations
Massachusetts

Project Transitions

March 2010: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Operations Mission Directorate (SOMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Human Spaceflight Capabilities

Project Management

Program Director:

David K Baumann

Project Manager:

Lauren B Leveton

Principal Investigator:

Charles A Czeisler

Co-Investigators:

Laura K Barger
Steven W Lockley

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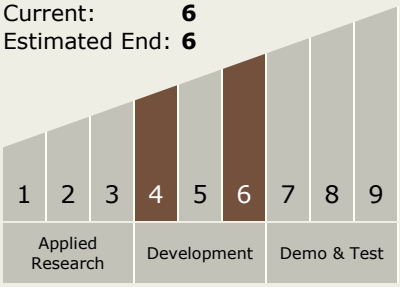
June 2015: Closed out

Closeout Summary: FINAL REPORT SUMMARY (Submitted September 2015): The success of a human spaceflight critically depends on the interaction between the crewmembers and the flight controllers. The ability of the crew and the controllers to remain alert and maintain high levels of cognitive function while operating and/or monitoring complex, technical equipment, is essential. Optimal human health, performance, and safety during space flight operations requires sufficient sleep and synchrony between the circadian pacemaker—which regulates the timing of sleep, endocrine function, alertness, and performance—and the timing of the imposed sleep-wake schedule. Flight controllers work rotating shifts, including nightshifts. Such schedules instigate significant circadian misalignment and acute and chronic sleep deprivation and consequently fatigue. Although the effects are often unrecognized, both the acute and chronic lack of sleep substantially degrades an individual's ability to react and think quickly, to make good decisions, and to recognize when fatigue is impairing his or her own performance and safety. Further, these elements of fatigue adversely affect personal health, increasing the risk of gastrointestinal and heart disease, impairing glucose metabolism and immune function, and substantially increasing the risk of injury due to motor vehicle crashes. In addition, it is likely that a substantial proportion of flight controllers suffer from undiagnosed sleep disorders which will further impair their sleep and exacerbate fatigue. The deleterious effects of fatigue are readily observed in a wide range of safety-sensitive professions and include increased risk of self-injury, higher rates of fatigue-related motor vehicle accidents, and greater incidence of serious errors. We implemented a Fatigue Risk Management Program (FRMP) for the flight controllers. The goals of this program were to reduce the adverse consequences of fatigue on the flight controllers' alertness, performance, health, and safety. The objectives of the program were to: Evaluate the current flight controller schedules (Phase 1); Develop an online education training program (Phase 2); Offer an efficient online screening for common sleep disorders (Phase 3); and Evaluate the acceptability, feasibility and efficacy of a combined fatigue countermeasure including shorter-wavelength light exposure during operational night shifts (Phase 4). Historical flight controller schedules were reviewed with regards to factors that affect physiological measures of alertness and scheduling recommendations were made to Mission Operations Directorate (MOD) management. We established collaboration with NASA Spaceflight Resources Management (SFRM) to develop a 9-module Fatigue Education Program tailored to flight controllers working Orbit 1 overnight shifts. The modules were released one-per-week to the entire MOD. In the ninth week, information was provided on common sleep disorders and flight controllers had the option of completing a short screening questionnaire to identify those at high risk for those disorders. Flight controllers (N=19) showed a small but non-significant (p=0.06) increase on the knowledge assessment scores after viewing the 9-part series, as compared to pre-viewing scores. We enrolled 17 flight controllers and 3 flight directors (9F, 33.3 ± 8.0 years [mean ± SD],) selected from the seven International Space Station mission control consoles regularly staffed for Orbit 1 operations (Flight, OPS Planning, ADCO, SPARTAN, ETHOS, CRONUS, Ground Control). Data were collected during one off-console week and each controller was scheduled to work two blocks (4-7 days each) of Orbit 1 shifts during the study. We randomized each block to either the control or experimental condition. During the experimental condition, controllers were encouraged to visit the Experimental Break Room (EBR) once before the shift, twice during the shift, as operations allowed, and following the Orbit 1 shift. The EBR provided subjects with passive exposure to blue-enriched fluorescent lamps (Sylvania Octron Skywhite XP ECO, 8000K) installed in ex

Technology Maturity (TRL)

Start: **4**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.3 Behavioral Health and Performance

Target Destinations

The Moon, Mars

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Stories

Abstracts for Journals and Proceedings
(https://techport.nasa.gov/file/64336)

Abstracts for Journals and Proceedings
(https://techport.nasa.gov/file/64338)

Abstracts for Journals and Proceedings
(https://techport.nasa.gov/file/64337)

Articles in Peer-reviewed Journals
(https://techport.nasa.gov/file/64333)

Articles in Peer-reviewed Journals
(https://techport.nasa.gov/file/64332)

Articles in Peer-reviewed Journals
(https://techport.nasa.gov/file/64335)

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Project Website:

https://taskbook.nasaprs.com